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UNION CARBIDE CORPORATION • NUCLEAR DIVISION
Oak Ridge Gaseous Diffusion Plant
OPERATIONS DIVISION

STANDARD OPERATING PROCEDURE

TITLE: OPERATION OF THE K-33 HYDRAULIC AND LUBE OIL SYSTEM

INTRODUCTION

Each unit in K-33 has two oil systems; one system supplies oil to operate the hydraulic stage control valves, and the other supplies oil to lubricate the compressor and motor bearings. Both systems are supplied from the same drain drums and utilize the same pumps for circulating the oil.

The unit oil system consists of a supply tank located in a penthouse on the building roof, two drain drums located on the operating floor, and connecting headers for supplying oil to the compressor and motor bearings and hydraulic control valves, and a return header which is common to both systems. Two pumps, one a spare, are located on the operating floor and pump the oil through a water-cooled heat exchanger to maintain the oil temperature to the compressor and motor bearings at 120°F. The oil pumped to the control valve system does not pass through the cooler. The oil is filtered through basket filters in each of the two systems. These filters are located on the pump discharge before entering the unit distribution headers. Additional filters are located at each half-cell distribution header for the bearing lube oil system and before each control valve in the unit hydraulic control valve system.

Each unit system contains approximately 22,500 gallons of oil of which 20,500 gallons can be contained in the two drain drums and the remainder in the headers. Under normal conditions, there are approximately 12,500 gallons of oil in the supply tank, 5,400 gallons in the drain drums, and 4,600 gallons in the system lines between the tanks. The supply valve to the supply tank and the drain valve from the supply tank are motor operated (MOV's), with controls and indicating lights on the unit utilities panels in the Area Control Room (ACR). A normal and emergency power supply is provided for the operation of these MOV's.

At each booster station the design is such that the lube oil supply and return lines may be valved to either the Unit 1 or Unit 8 oil system. The purge and evacuation station lube oil supply and return lines are similarly connected to the respective lines in Units 3 and 6. Oil is supplied from Units 3 and 6 to the seal exhaust and wet air pumps. This oil is not recirculated and must be changed periodically. A diagram of the K-33 unit lube oil system is presented in Figure 1.

DESCRIPTION

In each unit, oil from the drain drums is piped to two Fairbanks Morse centrifugal pumps, each with a capacity of 975 gallons per minute at 65 psig, supplying both systems. The hydraulic system is supplied at approximately 65 psig from the pump discharge. During normal operation, the valves from the discharge of both lube pumps to the hydraulic oil system must remain open. The valving at the hydraulic pumps must be as follows:

One pump suction and recycle valve must be closed and the discharge valve open. This applies to the hydraulic pump where the discharge line from the lube system pumps enters the hydraulic system. The other hydraulic pump valves should be closed. Both hydraulic system pumps are in standby.

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The bearing lube oil system is supplied through the pump discharge valve which is throttled to prevent pumping oil onto the roof through the system vents. The valve is in its proper position when adequate overflow comes from the supply tank to the drain tank.

The spare pump, when set on automatic control, will start whenever the level in the supply tank drops below the set point on a level controller. The set point coincides with the level in the supply tank at which there is an approximately 100-inch level and a visible overflow to the drain drum. At this point a low-level alarm on the unit utilities panel in the ACR is actuated. There is a low-level alarm installed on the drain drum which will actuate an alarm on the utilities panel in the ACR when the level in the drum drops below the alarm set point of the Fulscope level indicator. This set point should be approximately 0.5-inch below the normal level reading. An alarm light mounted on the bottom of the Fulscope indicates a low level condition.

The pumps discharge to the lube oil distribution system through double-basket type strainers which have a chain and sprocket arrangement for shifting inlet and outlet gates simultaneously. This permits the cleaning or replacement of one set of baskets while the flow is diverted through the other set. A diagram of these filters and basket strainers is shown in Figures 2 and 5. These strainers remove all solid particles larger than 0.005-inch in diameter and have a maximum pressure drop of 3.0 psi for a 30% plug. A high-pressure alarm is installed on the inlet line to the strainers. This alarm is set at 3 psi above the normal header pressure. At this point a high-pressure alarm will actuate on the unit utilities panel in the ACR, indicating a plugging condition exists at the unit strainers that are in service. There is a light installed on the alarm switch at the lube oil station which, when burning, indicates that the alarm switch power supply is energized. When the light is not burning, either the power supply is off, the light bulb is out, or the switch is in the alarm condition. The main unit oil strainers should be inspected routinely every six months to determine the amount of plugging and the condition of the wire screen basket.

Following filtering, the lube oil passes through the shell side of a water-cooled heat exchanger, which may be bypassed in an emergency. The capacity of the cooler is 5,600,000 BTU/hour, or the equivalent of cooling 975 gallons of oil per minute from 150°F to 120°F. The lube oil is then pumped to the unit supply header which is vented at both ends, and to the elevated supply tank which serves as a vented surge drum and should provide a 15-minute emergency supply in event of the failure of both oil pumps.

The hydraulic unit supply header can be vented at each end of the header through a valve and bull's-eye to the lube oil vent line. The supply tank has a 3-inch vent line, and the drain drums have a 4-inch common vent line to the roof of the building. The vents prevent a vacuum in the supply tank or a back pressure in the drain header or drain drums. The oil in the supply header to each half-cell passes through a block valve and double strainers on the operating floor and may be valved similarly as the main unit strainers for cleaning or replacing the strainer while the oil flow is diverted through the other strainer. These strainers remove all solid particles larger than 0.004-inch. The construction of these units is shown in Figure 3.

Each cell has supply piping divided into two branch headers which serve the odd and even banks of process control valves and the compressor and motor bearings. Separate branch lines supply each stage from the half-cell header. The lube oil flow for each half-cell system is throttled at the half-cell block valve to maintain 18 psig downstream of the half-cell filter, which is the proper pressure for the correct flow to the compressor bearings. A diagram of an axial compressor Kingsbury thrust bearing is shown in Figure 4. The half-cell hydraulic oil system is maintained at approximately 65 psig. The hydraulic control valve is designed to lock in the position it is in when the oil pressure drops to 50 psig.

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The oil supply to the unit hydraulic system passes through dual strainers which can be valved simultaneously to permit cleaning of one strainer while the oil is diverted throug the other strainer. These strainers are located at the unit lube oil station and will remove all solid particles larger than 0.005-inch. There are also dual filters located at each control valve; these filters remove all solid particles larger than 0.001-inch.

The flow to the compressor bearings is controlled by means of orifices at or in the beari assemblies. Flow to each of the motor bearings is adjusted by means of a visible drip Gits Oiler which is set to maintain approximately 120 drops of oil per minute. A valve on each supply line permits separation of the motor and compressor bearings from the unit supply system. In the event it is necessary to close the oil supply to the motor while repairs are being made, the motor is capable of continued operation providing there is sufficient oil in the bearing reservoir. A bull's-eye sight gauge on the 1750-hp motors and a J-tube sight gauge on the 2000-hp motors provide a visual indication of the oil level in the motor bearings. It is extremely important to note, however, that the oil supply to the bearings of running compressors cannot be valved off, even for a few second:

The oil flows by gravity from each control valve, compressor, and motor bearing, through the branch and main return header to the drain drums. The oil from the compressor bearings passes a flame arresting vent and through a bull's eye sight glass before reaching the branch line of the cell return header. The vents eliminate the possibility of a vacuum being pulled by the oil flow in the return lines. The unit return lines are pitched to insure gravity flow to the drain drums.

The overflow from the supply tank to the drain drums is through a weir box. The weir regulator is a 10.8-inch inverted V cut into one side of a 14-inch deep box that is mounted on a 97.2-inch standpipe inside the supply tank. The weir is so designed that the amount of oil which overflows to the drain drums is directly proportional to the height of oil above the lower edge of the weir plate, approximately 5 gpm per inch of level in the weir box.

The amount of overflow can be seen through a bull's-eye sight glass mounted in the overflow lines at the top of the drain drums and is controlled by throttling the pump discharge valve. The level in the supply tank can be read on remote level indicators located at the drain drums and in the ACR, as well as on the sight glass at the supply tank. The supply tank room is heated by a 12-inch diameter pipe which extends through the floor of the penthouse for approximately 30 inches and brings in hot air from the cell floor.

Both the supply and the drain drums are mounted within concrete diked areas. These pits would contain the oil from an oil break or spill at these locations. The supply tank diked area has a 4-inch drain line leading from the pit floor to the drain drum diked area. Therefore, the oil from a spill at either location would accumulate at the drain drum area where it could be filtered for reuse.

Whenever necessary oil can be added to a unit system through a charging line at the drain drums. A manifold is connected to the charging line and air pressure is used to force the oil from a supply tank wagon into the drain drums. It is also possible to add oil to the system through a recovery filter which is connected to the unit lube oil return line located in the center of each unit on the cell floor. There is another line at the drain drums where a portable pump, mounted on a dolly on wheels, is utilized for pumping back the oil drippings through a filter to the drin drums. These connections are used to return small quantities of oil to the system.

Each lube system is equipped with a molecular sieve which consists of a steel container filled with a 75-pound charge of type 4A Linde molecular sieve material. A flow of oil is routed through the sieve from the discharge of the operating lube pump and is returned through a purolator-type filter to the top of the auxiliary lube supply tank. Screens are installed in the inlet and outlet of the molecular sieve bed to contain the pellets to the sieve.

The function of the molecular sieve is to remove the moisture and varnish from the oil. The interfacial tension (IFT) of the oil is maintained above 20 dynes/cm and the neutralization number is maintained below .15. Samples of the oil before and after the sieve are taken monthly and checked for the IFT and neutralization number. Valving is provided to allow the pellets to be replaced as needed. The frequency of pellet changeout is determined by the ΔP across the bed and results of the oil samples.

PROCEDURE

1. It should be noted that the motorized lube oil supply valve is located between the pump discharge and the supply tank. Operation of a lube oil pump with this valve closed will result in discharge of oil onto the roof. Thus the lube oil supply valve must always be 100% open any time a lube oil pump is running.
2. The motorized drain valve from the lube oil supply tank is intended to permit emergency draining of this tank. In the event of a roof fire, for instance, the supply tank should be drained as rapidly as possible after shutting down the running process equipment.
3. Lube oil flow is the lifeblood of the cascade process equipment. A normal lube oil flow is necessary for operation of all compressors and motors, and a restricted oil flow is reason for immediate shutdown.
4. Low level alarms on the unit supply tank could indicate that the pump discharge valve is throttled too much while low drain tank level could indicate that lube oil is being lost from the system through a line break or other leak.

The following items should be checked each shift:

1. All unit lube oil pumps, motors, couplings, and Gits Oilers, for defects such as leaks, excessive vibration, and high temperature.
2. The pump discharge should be between 67-70 psig as read on the hydraulic PI at the lube station, and approximately 40 psig downstream of the lube oil system strainer. If the pressure drop across the lube strainer exceeds 2.5 psi or the hydraulic oil system cannot be maintained at 65 psig, switch the basket strainers and have the plugged strainer baskets cleaned.
3. The drain drum level should have a minimum of 22 inches and a maximum of 25 inches.
4. The supply tank level should be approximately 104 to 108 inches on the sight glass, and from 96 to 100 divisions on the PI (98 divisions is the ideal level).
5. Maintain 18 psig downstream of the half-cell filter by adjusting the half-cell block valve. If 18 psig cannot be maintained, switch the filter and have the plugged filter cleaned.
6. If the half-cell supply header cannot be maintained above 15 psig, shut down the cell motors until the situation can be corrected.
7. At any time the oil system has been opened by Maintenance, be certain that adequate flow is established to the bearings before the equipment is returned to service.
8. Following a stage motor replacement, the new motor bearing reservoir must be filled with oil before the motor is started (1 gallon of oil per bearing on 1750-hp, 1/2-gallon per bearing on 2000-hp).
9. Following compressor bearing failure, the half-cell and unit lube filters should be checked for plugging.
10. The entire lube system should be checked frequently for leaks, line breaks, and plugging of vents.

Supply Tank Alarm and Spare Pump Operation Check

Each Sunday on the 4-12 shift, the low-level controls on the supply tanks and operation of the spare pump should be checked:

1. Throttle the pump discharge valve of the operating pump or drain the LIM float chambe
2. The audible and visible low-level alarm should actuate and the spare pump should sta when the level drops to approximately 93 divisions on the level PI at the unit lube station and on the unit utilities panel in the ACR.
3. As soon as the spare pump is operating normally, close the vent valve on top of the pump. This vent prevents a vapor lock when starting the pump.
4. Turn the selector switch to manual control on the pump just started.
5. Shut down the pump which had been running if not done in Step 1.
6. Establish the normal oil level in the supply tank by adjusting the pump discharge valve.
7. Open the vent valve on the down pump.
8. After the low-level alarm light goes out, turn the selector switch on the down pump to automatic control. The down pump cannot be started automatically if the selector switch is set for manual control.

Drain Drum Alarm Check

Check the drain drum alarm each Monday on the 4-12 shift as follows:

1. Close the valve on the line from the bottom of the drain drum to the sight glass and alarm level chamber.
2. Drain the alarm level chamber into the drum located below the drain drum until the alarm actuates on the utility panel in the ACR and the red light comes on at the level Fulscope indicator.
3. The alarm should actuate when the sight glass indicates a half-inch decrease in level. If it does not actuate, reset the Fulscope until it does.
4. Return the alarm chamber valving to normal.

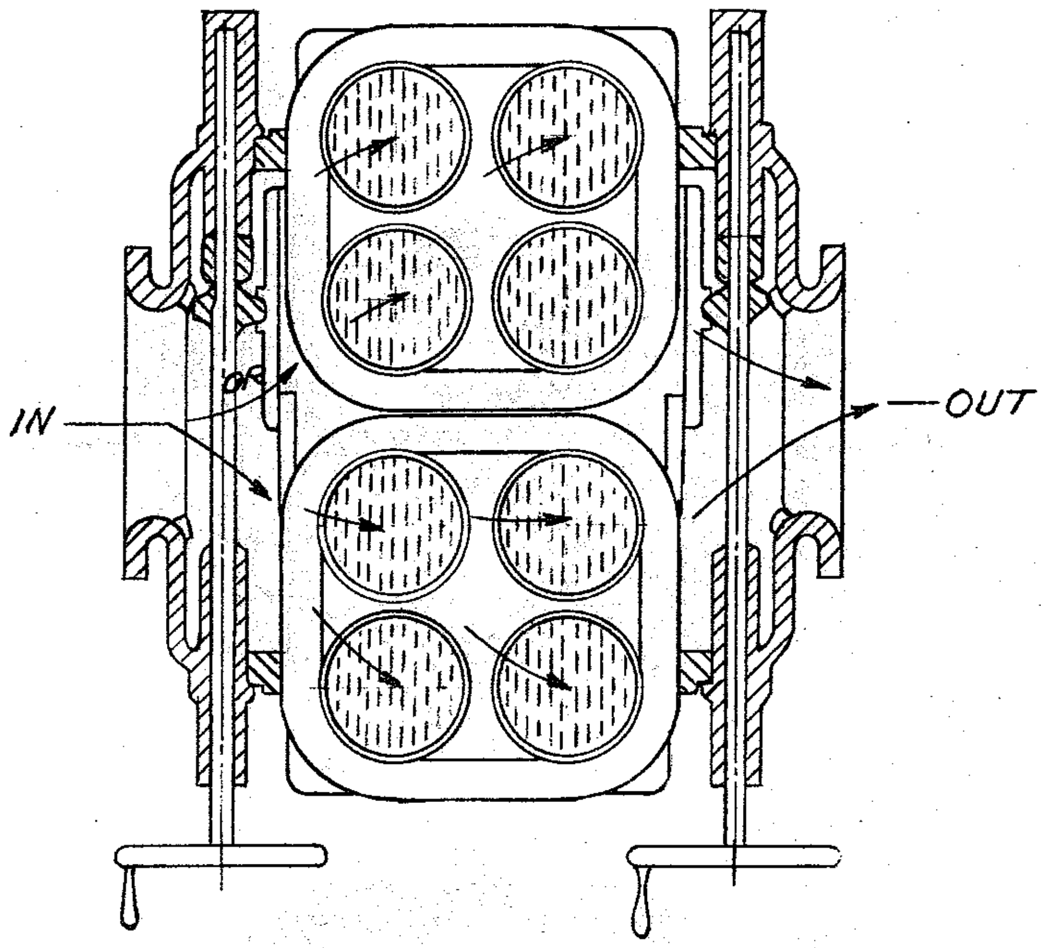
Filter Inlet High-Pressure Alarm Check

Each Sunday on the 4-12 shift, check the main oil filter inlet high-pressure alarm as follows:

1. Slowly open the throttled discharge valve of the operating pump until the pressure on the filter inlet increases 3 psig. If the level in the supply tank increases, or the low-level alarm actuates on the drain drum, return the pump discharge valve to normal and establish the proper overflow from the supply tank to the drain drums.
2. The audible and visible high-pressure filter inlet alarm should actuate on the utilities panel in the ACR, and the light on the alarm switch at the lube station should stop burning when the filter inlet pressure increases 3 psig.
3. Adjust the pump discharge valve to establish proper overflow from the supply tank to the drain drum.

Approved: WDMcCluen

W. D. McCluen, Superintendent
Cascade Operations Department



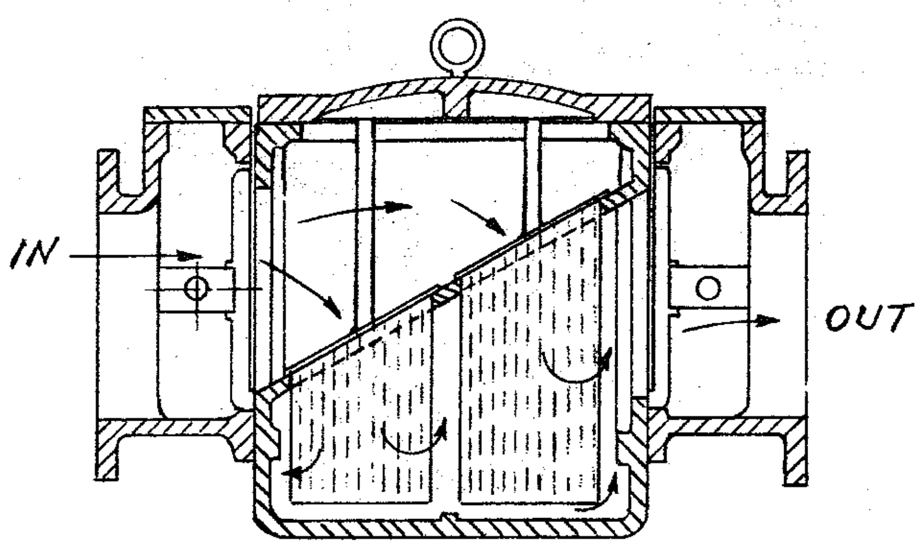


Figure 2

MAIN UNIT FILTERS

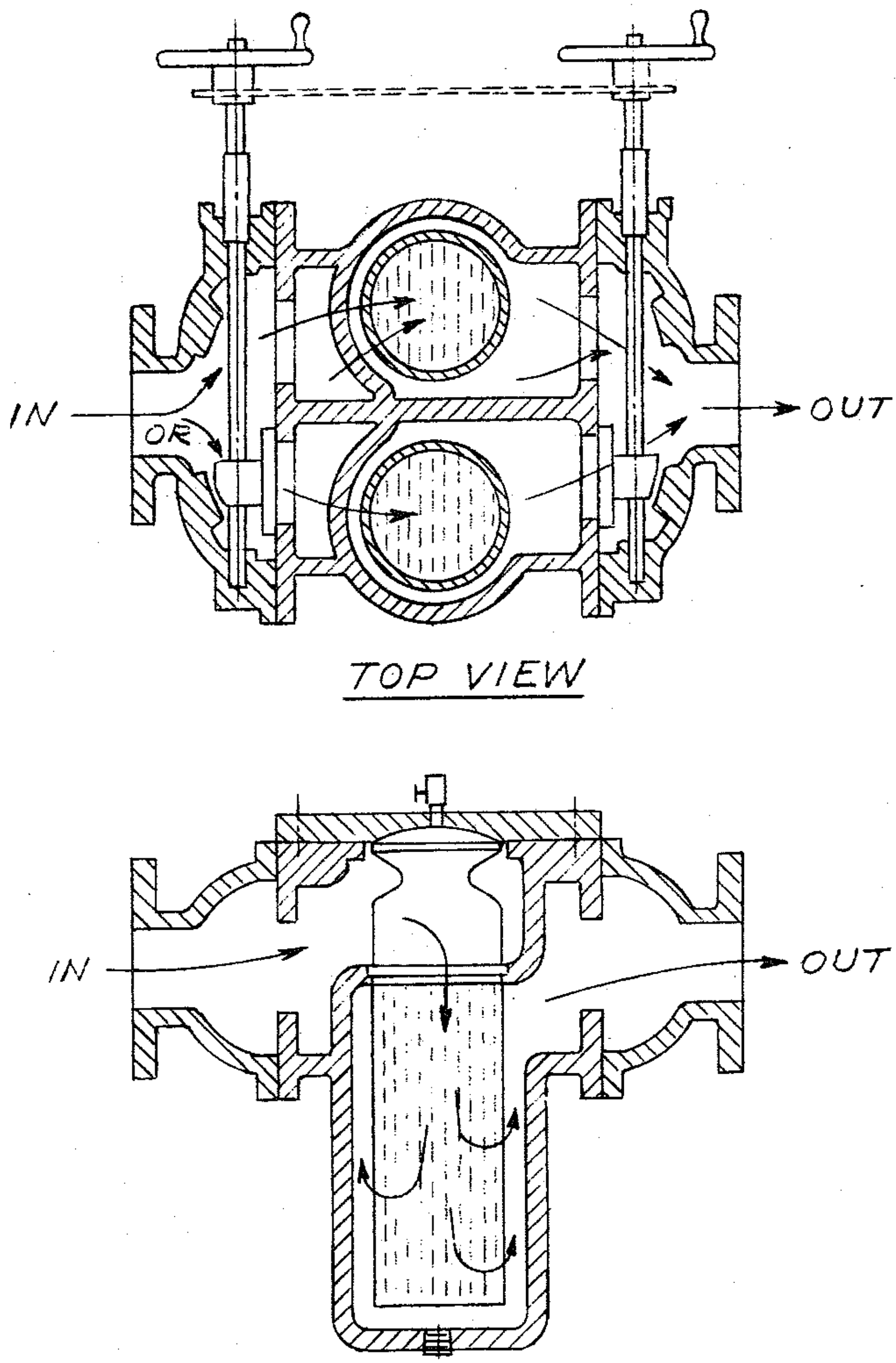


Figure 3

HALF CELL FILTERS

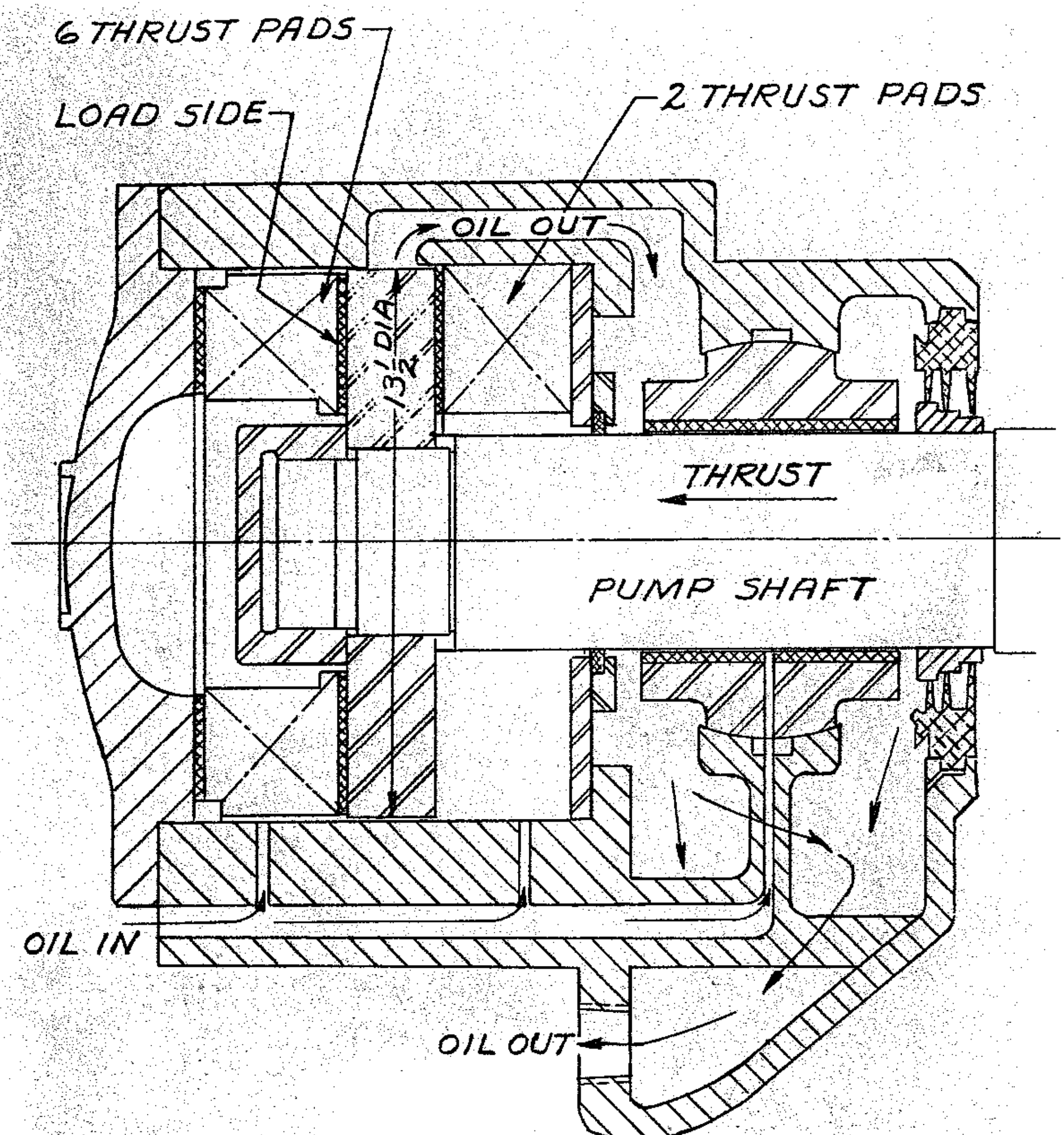


Figure 4

K-33 KINGSBURY THRUST BEARING

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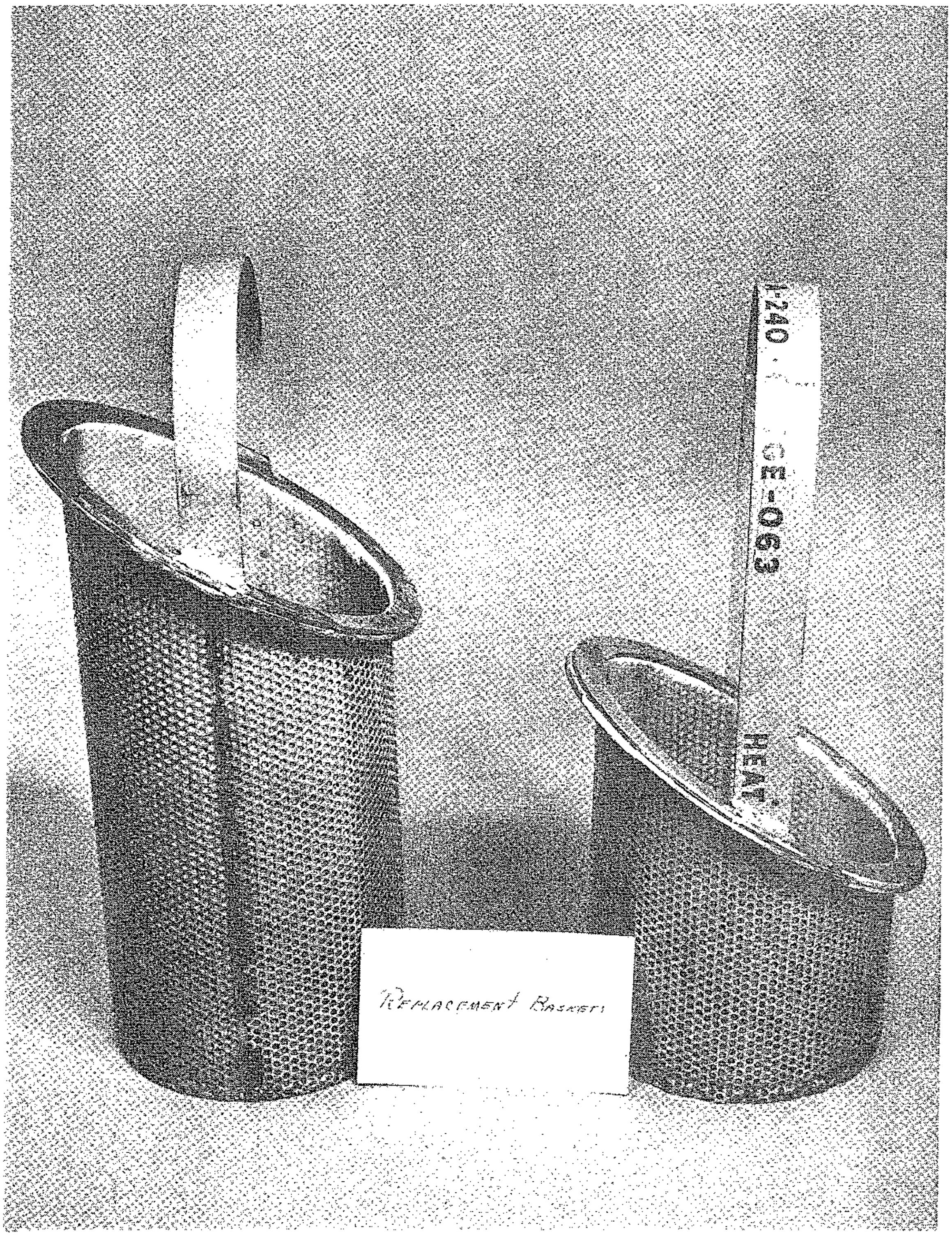


Figure 5
REPLACEMENT BASKETS

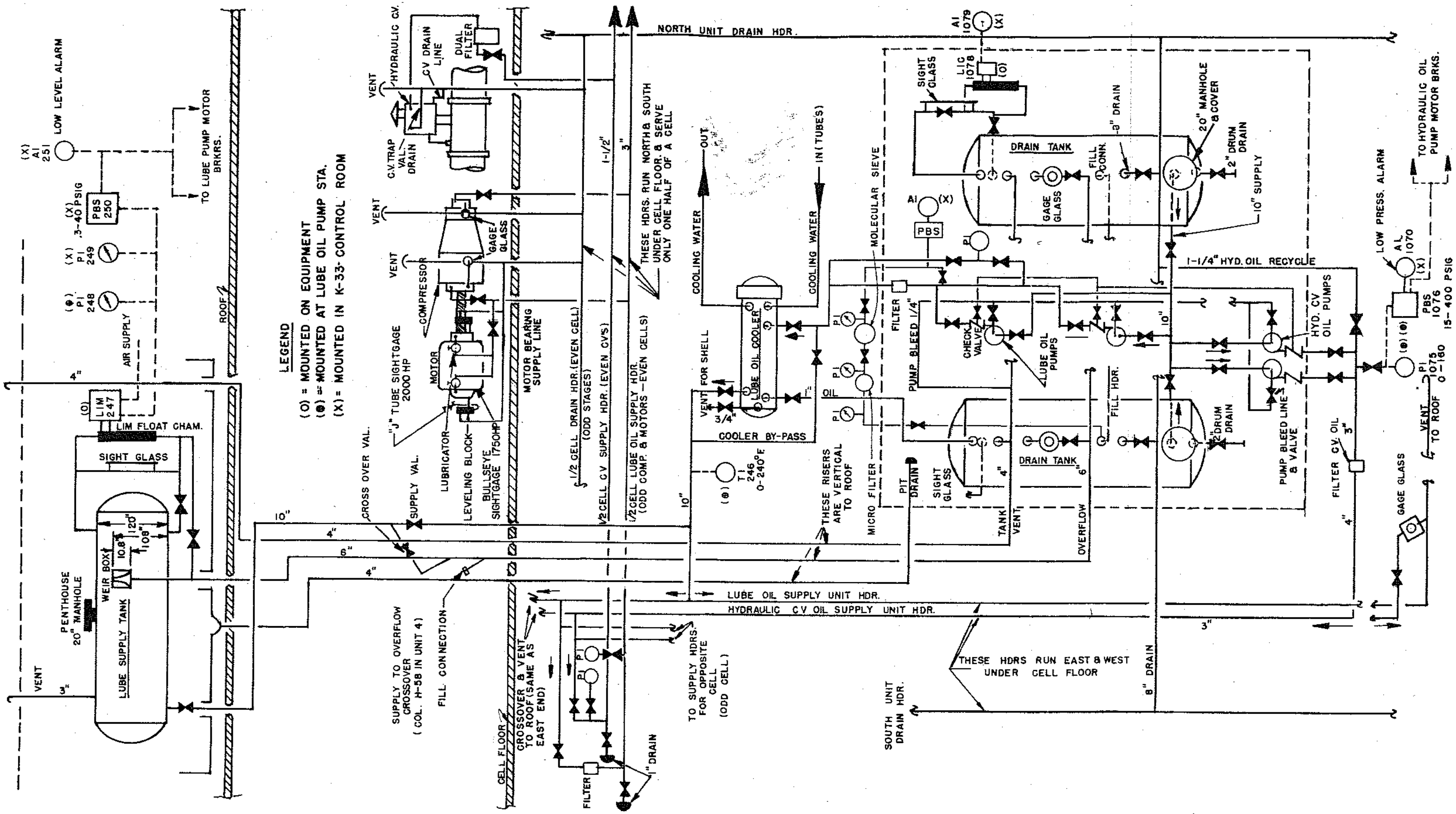
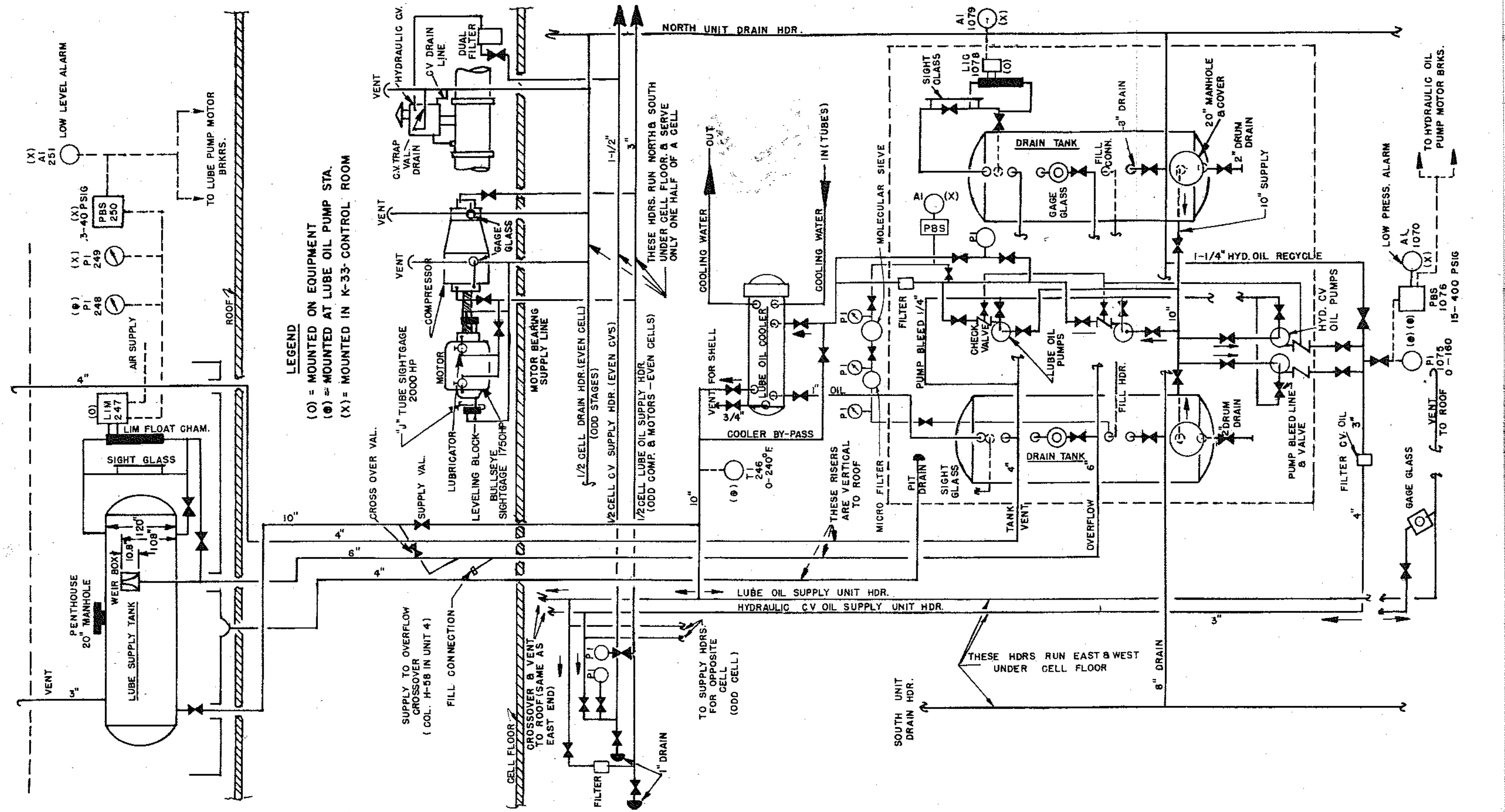


Figure 1

K-33 LUBE OIL AND HYDRAULIC OIL SYSTEM (TYPICAL UNIT)



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